AN EFFICIENT 3D VOLUME RECONSTRUCTION METHOD FROM GENERALLY CLASSED PLANAR CONTOURS

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Recent advances in the fields of medicine, geophysics, and materials science have driven the need for more powerful methods to build complex 3D geometries of multiple connected objects. Specifically, there is a desire to apply finite element models to objects having connected regions with multiple tissue types, or multiple sediments types, or multiple grains. To date, most 3D reconstructions from planar contours have considered only one region, or iso-surface, at a time. Gaps and overlaps occur when this approach is applied to multiple bodies. More recent efforts have generalized Marching Cubes [1] to handle generally classed structures, where multiple bodies or regions meet at points, lines, and surfaces. However, these approaches are complex and numerically inefficient. They also require a large number of cells and result in a large number of surface facets to achieve a fine resolution.

We propose a computationally efficient method for reconstructing planar contours. The method has adaptive resolution and low memory requirements. The method applies a 3D Delaunay tetrahedralization to all the contours on all of the planar slices. Steiner points [2] are added to enforce a conforming condition where all the original contours are kept intact. The contours from adjacent slices are joined together using tetrahedrons, such that the entire volume is filled. If necessary, the tetrahedrons are then subdivided into a collection of tetrahedrons, where each tetrahedron has only one body or material type. The result is a geometric description, where material or region interfaces are consistent in that there are no gaps or overlapping regions.

The output from this approach is two-fold. First, the volume description can be passed to solid modeling programs for further processing and/or for mesh refinement. Secondly, the surface boundaries between grains are passed to programs that require surface models. The surface boundaries may also be sent to packages that estimate the interface properties between grains for materials science studies. This paper will present examples and results for polycrystalline solids from the field of materials science.

References

[1] H.-C. Hege, M. Seebaß, D. Stalling, and M. Zöckler, "A Generalized Marching Cubes Algorithm Based On Non-Binary Classifications", *Technical Report SC-97-05, Konrad-Zuse-Zentrum für Informationstechnik (ZIB)*, 1997.
[2] J.R. Shewchuk, “Definitions (of several geometric terms),” The Quake Project, http://www-2.cs.cmu.edu/~quake/triangle.defs.html